Space Weather Technical Forecast

Issued on Monday, 07 February 2022 at 13:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Partial halo CME observed from near centre-disc filament eruption. G1 Likely midweek. Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional C-class X-ray flares observed at GOES 16. The largest of these events was a long-period C3.1 X-ray flare, peaking at 06/1341UTC. This was associated with a near-centre disc filament eruption that was visible in many EUV wavelengths, with this emanating from the immediate east of sunspot region 2939. The emission itself appeared helicoidal and well-scattered given the face-on viewing angle, being directed mainly along and below the ecliptic plane, perhaps centred very slightly east of Earth. With reference made to STEREO A COR2 and Lasco imagery, this feature has been modelled as three separate CMEs to provide a best match - with two of these fronts mainly angled below the ecliptic, but the third (the innermost and slowest) bearing a likely Earth-bound component. Discussion as to the effects of this emission appears in the Geomagnetic Storms section of this guidance document.
During the past 12 hours AR2938 (Dri/Beta) has transitioned round the western limb to the far side, leaving four sunspot regions on the Earth-facing disc, including the aforementioned 2939, with this group finishing the 24 hours as a Chi/Beta-Gamma. The two most noteworthy groups in terms of size are AR2940 and AR2941. AR2940, in the northwest, showed a slight increase in its intermediate portion, whilst AR2941, in the northeast, grew longitudinally. However, neither region produced any significant flares. The remaining region AR2942 in the southwest has decayed and is now a small simple uni-polar spot.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, has displayed the effects of a waning negative coronal hole, with elevated wind speeds gradually declining from around 550 km/s to around 500 km/s. The density has been average or slightly above average, between 6 and 12 ppcc. The total magnetic field has been weak, with the north-south component ranging +/- 3 nT. The phi angle was in negative (towards the Sun) orientation throughout. Corresponding geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux has been at High levels throughout, peaking at 4440pfu at 06/1505UTC. Electron fluence values are above the Active threshold and have shown a sustained rise from 1.84e8 integrated pfu at 07/0000UTC to 2.63e8 integrated pfu at 07/1200UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low in the period, with further C-class flares expected and a chance of M-class, most likely from AR2939, AR2940 or AR2941, which are likely to remain present on the Earth-facing disc throughout the four days.

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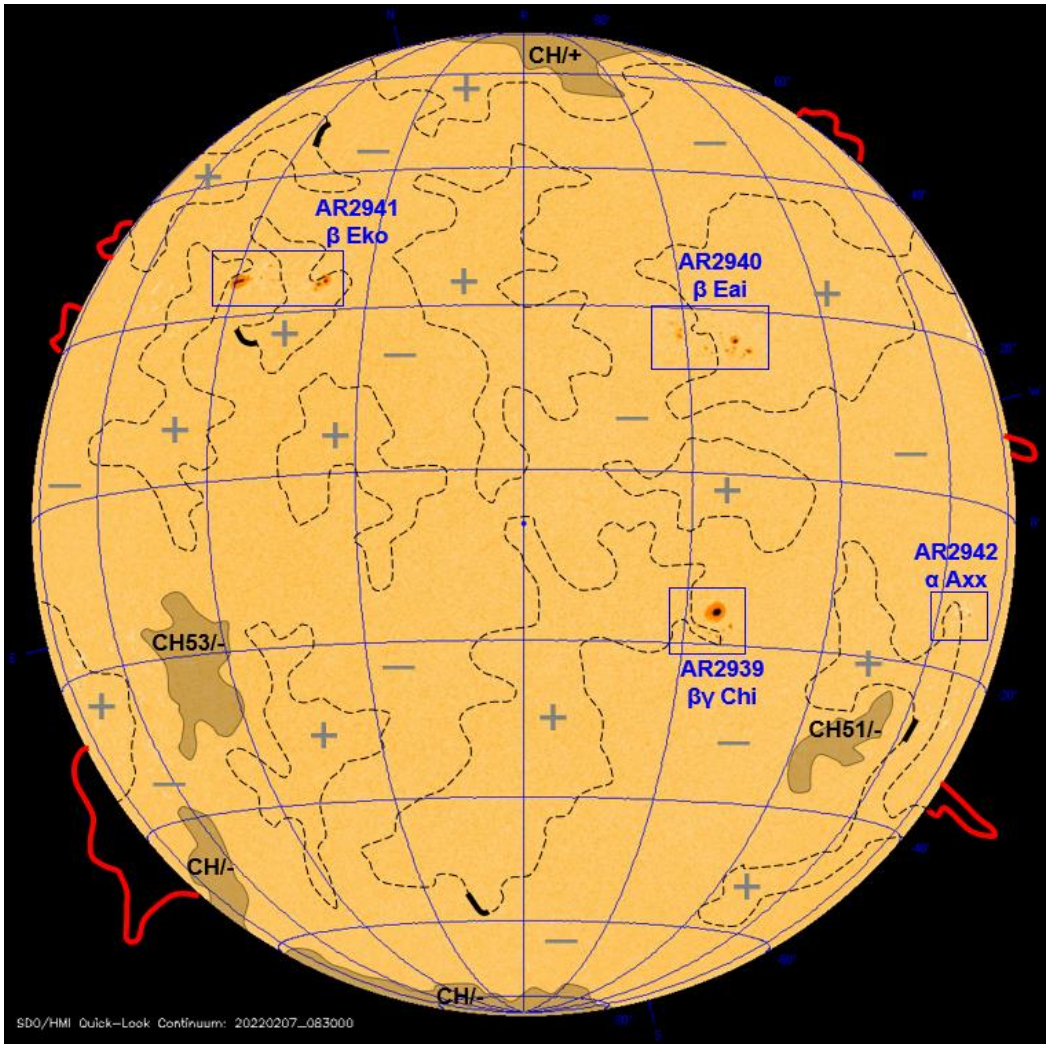
Solar Wind / Geomagnetic Activity: The current fast solar wind regime is likely to be the peak persistent feature in the four-day period, and is now expected to gradually wane. There is then the consideration of the possible arrival of the 06 February filament eruption CME, which has been modelled and offers a Likely G1 on day 3 (9th) and continuing as a Chance into day 4 (10th). There is an accompanying Slight Chance of G2, with this not the favoured scenario but most probable near onset should it occur.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels, but with a slight chance of rising close to or just above the S1 level given any significant M-class flaring.
High energy electron flux (greater than 2MeV) is expected to continue near current diurnally High flux levels through to midweek. Electron fluence is also expected to remain above the Active (1e8 integrated pfu) threshold in an undamped response to the high speed stream from CH49/CH51. This is also likely to continue until the onset of the CME from the 06 February filament eruption, currently thought most likely to arrive on day 3 (9th). Should this CME be delayed, there is a Chance of Active fluence surviving as late as day 4 (10th).

Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Earth is currently sampling a relatively stable negative polarity high speed stream - probably that from CH49, but perhaps blending with the succeeding negative coronal hole CH51. These are the only persistent features due in the four-day period, and activity arising from these is likely to have peaked, with a gradual decline towards ambient levels over the next 24-36 hours.
The dominant consideration for geomagnetic activity in the period is therefore the potential arrival of the CME from the filament eruption peaking 06/1341UTC from south centre-disc. As discussed in the solar activity section, this emission was very apparent on many EUV image sequences, not least AIA304, where, from an Earth perspective, the ejecta can be seen to rotate clockwise and scatter above, below and onto the ecliptic plane, perhaps mainly orientated very slightly east of Earth's position. MOSWOC Enlil modelling has been conducted using STEREO A CO2 and Lasco C2 imagery, providing a relatively clear correlation. Modelling has resulted in up to three main shock fronts, with two faster emission angled mainly below the Earth, but a third slower emission with a potential Earth-bound component.
MOSWOC Enlil modelling suggests a most likely arrival time of 10:00UTC on Wednesday 09 February, although with error bars factored in, effects are probably best described as becoming apparent during the second half of the remainder of this UTC day, and into the start of the following day (10th). The deterministic run sits fairly centrally within its ensemble in terms of arrival time and magnitude, with this considered the best forecast given available imagery. This may perhaps to be improved upon with increased Lasco C3 imagery - should this become available.
All considered, G1 intervals from the current waning high speed stream have probably peaked, soon tailing off into the new working week. G1 is then considered Likely for the inbound CME, with perhaps a slight chance of G2, partitioned between the final two days of the period, but with a bias towards greater effects nearer onset.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	60	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/0003	Partial	Filament eruption near AR2939	Centre disc	408	09/1000 UTC	Modelled as 3 separate shock fronts. With ETA the most likely to be Earth-bound but slowest.

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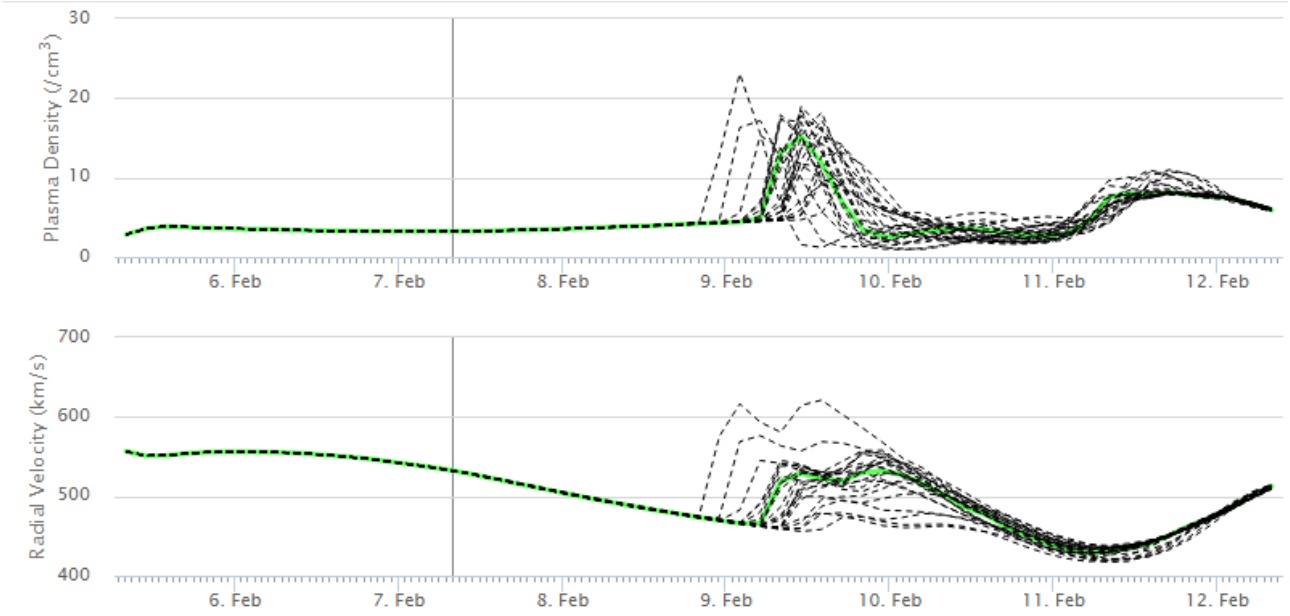
Figure 2: MOSWOC Enlil ensemble showing arrival time estimates for the 06 February filament eruption CME.



Radio Blackouts - X-Ray Flares:

No significant returning or newly-developed regions appear to lie over the eastern horizon according to STEREO A EUVI195 imagery. Meanwhile, up to two current front-sided regions may leave into the new working week - the larger AR2938 in around 24 hours' time, and AR2942 around midweek UTC. Neither of these groups is contributing significantly to the daily flare risk, meaning that the decline as a result of their passing is very modest.
The remaining daily flare risk is on paper dominated by the two Zurich E groups, however these have been relatively inactive, with the largest event of the past 24 hours instead coming from immediately east of the smaller region AR2939, a Chi/Beta-Gamma. Perhaps because of the maturity of the current disc and the slow rates of change observed, activity from the current front-side is tracking below expectations, however a daily Chance of M-class flares is maintained for now, reducing slightly as the number of front-sided groups reduces.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a very slight chance for proton fluxes to rise given any significant flaring as AR2939 and AR2940 move across the western hemisphere.

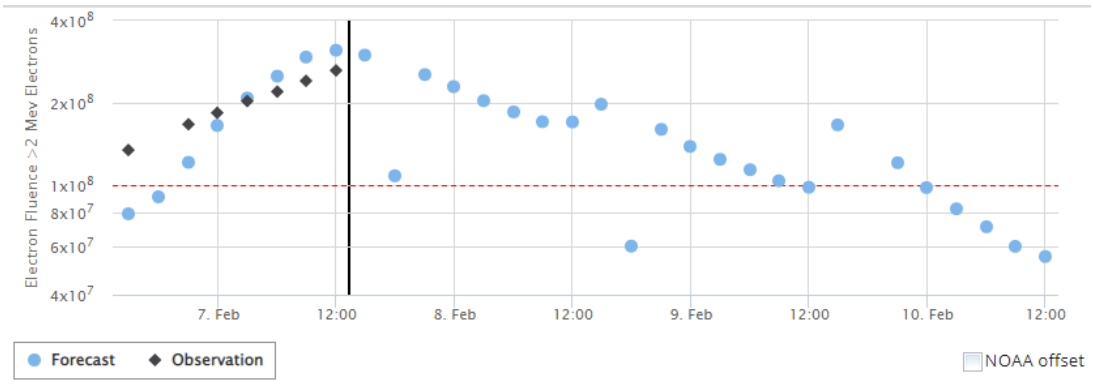
Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is currently exhibiting a stable oscillation peaking at High levels, and is expected to retain this character until around midweek and the possible onset of the 06 February filament eruption CME. This feature is likely to significantly redistribute electrons when it arrives, which could be late as day 4 (10th), hence the survival of a Chance of Active fluence until this time.
There are no further persistent features to re-elevate electron flux counts in the period, although a degree of recovery is possible before the UTC weekend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	5	5	1

Figure 3: GOES 16 observed electron fluence and REFM data.



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